CONTINUATION PATENT APPLICATION

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MODULAR KNEE JOINT PROSTHESIS

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MODULAR KNEE JOINT PROSTHESIS

This application is a continuation of co-pending Application Serial No. 10/185,492, filed on June 28, 2002, the disclosure of which is hereby totally incorporated by reference in its entirety.

Background of the Invention

[001] The present invention relates to prosthetic joints, and particularly to a prosthesis for the knee joint.

[002] Implantable knee prostheses for diseased and/or damaged knees typically include three components, namely a femoral component, a tibial component and a meniscal component. The femoral component may also include a patellar element, or a separate patellar component may be provided. The prosthesis components are generally configured to restore or emulate as much of the natural motion of the knee joint as possible. The selection of the particular prosthesis components is usually dictated by the condition of the patient's knee. For instance, the condition of the distal end of the femur and proximal end of the tibia, as well as the patency of the surrounding ligaments and soft tissue can affect the form of the joint prosthesis.

[003] Generally, a total knee joint replacement includes a tibial component having a platform portion which replaces the entire superior surface of the tibial plateau and substitutes for the tibial condylar surfaces. The femoral component also includes laterally-spaced condylar portions joined by an inter-condylar bridge and a patellar surface.

[004] The tibial component typically includes a tibial tray and stem for surgical attachment to the proximal end of the tibia. The component also includes an intermediate articulating surface member that is connected to the tibial tray. The intermediate member defines a bearing surface for articulation of the femoral component thereon. The mating surfaces are smoothly curved in the anterior-posterior (AP) direction to generally match the lateral profile of the

natural femoral and tibial condyles, and to ultimately replicate the normal joint movement.

[005] This normal joint movement includes a translational component in the AP direction, as well as a rolling of the femoral condyles on the tibial condyles when the knee is flexed. In addition, the natural tibia is capable of rotation relative to the femur about the axis of the tibia. Thus, an ideal knee prosthesis will be able to achieve all three degrees of freedom of movement. In some cases, the patient's knee lacks adequate posterior support due to a deficient posterior cruciate ligament. In these cases, the modular knee is preferably posteriorly stabilized, meaning that posterior movement of the tibia relative to the femur is restricted. This posterior stabilization can be achieved in a typical implant by a projection or eminence on the tibial insert that engages a box-like intercondylar portion of the femoral component. Intact collateral ligaments keep the projection within the box-like portion as the knee is flexed to inhibit dislocation of the joint at hyper-extension or hyper-flexion.

[006] In order to increase the lifetime of the prosthetic knee joint, the mating bearing surfaces between the tibial and femoral components generally permit a combination of rolling and translational movement as the knee joint is flexed. These two degrees of freedom of movement change the direction of forces between the two components so the force transmitted through the joint is not focused on one location. In response to this optimum design aspect, some prosthetic knees include a translating intermediate bearing component. One problem with modular implants of this type is that the articulating and sliding components can be exposed to the soft tissue surrounding the joint.

Summary of the Invention

[007] In one embodiment of the invention, a modular joint prosthesis comprises a first joint component having a bone engaging portion, an articular surface, and a recess defined within the articular surface. The prosthesis further includes a mating component having a bone engaging portion and defining a bearing surface for sliding contact with the articular surface of the first joint component. In one feature of the invention, a stabilizing post is slidably mounted to the mating component amid the bearing surface with the post projecting from the mating component and into the recess when the articular surface is in contact with the bearing surface.

[008] In certain embodiments, the mating component includes a second joint component including the bone engaging portion and an intermediate component connected to the second joint component, the intermediate component including the bearing surface. When the modular joint prosthesis is a total knee prosthesis, the first component is the femoral component, the second component is the tibial component and the intermediate is the meniscal component.

[009] The second joint component can define a bore, while the intermediate component can includes a pin sized to be received within the bore. The bore and pin can be configured to permit relative rotation therebetween when the pin is received within the bore to add a rotational degree of freedom between the femoral and tibial components.

[0010] In one aspect of the invention, the mating component or the intermediate component defines an elongated channel. The stabilizing post includes a base configured for sliding engagement within the channel and a spine projecting from the base through the channel and into the recess when the articular surface is in contact with the bearing surface. In certain embodiments, the channel is open at one end. In these embodiments, a locking member can be provided that is configured to close the one end with the base of the

stabilizing post disposed within the channel. The locking member can be configured for a press-fit within the channel.

[0011] In some embodiments, the channel includes an enlarged groove at opposite sides of the channel. The base of the stabilizing post can then be configured for sliding engagement within the grooves, while the locking component can be configured for locking engagement within the grooves. Preferably, the channel has a length greater than the length of the base so that the base can translate within the channel.

[0012] The recess of the first joint component can define surfaces at its opposite ends. The stabilizing post preferably includes a face opposing each of the opposite end surfaces. The recess surfaces and a corresponding opposing face of the stabilizing post are configured to provide a camming movement of the stabilizing post as the recess end surface moves in contact with the opposing face. Thus, as the first joint component rolls and translates relative to the mating component, the camming movement causes the stabilizing post to slide between the ends of the channel.

[0013] In some embodiments, two faces of the stabilizing post are differently curved to provide different camming effects at opposite ends of the channel. In one feature of these embodiments, a plurality of stabilizing posts can be provided having different profiles. An appropriate stabilizing post can be selected during a total knee procedure to optimize the movement of the resulting prosthetic joint.

[0014] It is one object of the present invention to provide a prosthetic joint that permits relative rolling and translation between two bone engaging components. A further object is achieved by features of the invention that reduce the exposure of articulating surfaces and components of the prosthetic joint to soft tissue surrounding the joint.

[0015] These objects and certain benefits of the invention can be ascertained from the following written description taken together with the accompanying figures.

Description of the Figures

[0016] **FIG. 1** is an exploded perspective view of the components of a joint prosthesis in accordance with one embodiment of the invention.

[0017] **FIG. 2** is a side exploded view of the intermediate component of the joint prosthesis shown in **FIG. 1**.

[0018] **FIG. 3** is a top elevational view of the intermediate component shown in **FIG. 2**.

[0019] **FIG. 4** is an end elevational view of the intermediate component shown in **FIG. 2**.

[0020] **FIG. 5** is a side elevational view of the intermediate component shown in **FIG. 2**, with the stabilizing post shown in different positions.

[0021] **FIG. 6** is a side elevational view of the femoral component of the prosthetic joint shown in **FIG. 1**.

[0022] **FIG. 7** is a side elevational view showing one position of the femoral component relative to the intermediate component of the prosthetic joint shown in **FIG. 1**.

[0023] **FIG. 8** is a side elevational view showing another position of the femoral component relative to the intermediate component of the prosthetic joint shown in **FIG. 1**.

Description of the Preferred Embodiments

[0024] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and described in the following written specification. It is understood that no limitation to the scope of the invention is thereby intended. It is further understood that the present invention includes any alterations and modifications to the illustrated embodiments and includes further applications of the principles of the invention as would normally occur to one skilled in the art to which this invention pertains.

[0025] Referring first to **FIG. 1**, a modular joint prosthesis **10** is depicted that comprises a first joint component **12**, a second joint component **14** and an intermediate joint component **16**. From the perspective of a knee prosthesis, the first joint component **12** can be referred to as the femoral component, the second joint component **14** as the tibial component, and the intermediate joint component **16** as the meniscal component.

[0026] The femoral and tibial components can be configured according to known designs for these elements. For the purposes of the present disclosure, certain details of these components will be described. The femoral component **12** can include an articular surface, or more particularly a pair of condylar articular surfaces **25**. These surfaces are smoothly curved and configured to emulate the shape of the natural femoral condyles. The component **12** also includes a bone engaging portion **27** which can include fixation posts **28**. The bone engaging portion **27** can be configured in a known manner for attachment to the distal femur. The femur can be prepared in a conventional manner to accept the femoral component **12**.

[0027] The femoral component **12** can further include a patellar element **30** that is integral with the articular surfaces **25**. A separate patellar element can also be provided for connection to the femoral component. The component **12** also includes an intercondylar recess **32** which is preferably a box-like structure spanning the AP dimension of the component. A slot **33** can be included in the

proximal face of the recess **32**. In one feature of the femoral component **12** of the present embodiment, a tab **34** can be provided at the posterior end of the recess **32**. The tab **34** can operate as a control for roll-back of the tibia relative to the femur as the joint is articulated.

[0028] The tibial component **14** can be in the form of a conventional tibial tray. The component includes a proximal surface **35** that parallels the tibial plateau cut into the proximal end of the tibia to receive the component. A fixation stem **37** projects downwardly from the tibial tray and is configured for solid, permanent fixation within the prepared end of the tibia. A connection bore **39** extends from the proximal surface **35** into the fixation stem **37**. The bore is configured to receive a mating stem **45** of the intermediate joint component **16** in a known fashion. To approximate the shape of the prepared end of the tibia, the tibial component **14** can define a posterior recess **41**.

[0029] Turning now to the intermediate component **16**, details of its design can be gleaned from **FIGS. 1-4**. In general, the intermediate component can be configured like similar components from known modular knee prostheses. Thus, the intermediate component **16** can include opposite spaced-apart bearing surfaces **43** that are configured for articulating contact with the articular surfaces **25** of the femoral component **12**. The component **16** can also include a rotation pin **45** that is rotatably mounted within the connection bore **39** of the tibial component **14**. The interface between the rotation pin and the tibial component bore can be of conventional design that permits relative rotation between the intermediate component **16** and the patient's tibia. In the illustrated embodiment, the axis of rotation of the intermediate component **16** is at the center of the component and of the tibial component **14**; however, other axes of rotation are contemplated as required for the particular joint anatomy and the desired movement of the joint prosthesis.

[0030] In a modification from prior intermediate components, the component **16** of the present invention includes a channel **47** defined between the spaced-apart bearing surfaces **43**. In general, the position of the channel **47**

corresponds to the position of the recess **32** of the femoral component **12** when the two components **12** and **16** are in articulating contact. The channel **47** can include a posterior opening **49** at the posterior side of the intermediate component **16**. A stop surface **51** is provided at the closed anterior end of the channel **47**. Opposite grooves **53** can be formed at the base of the channel **47** for reasons set forth below. As shown in the figures, the channel **47** extends substantially along the entire AP length of the intermediate joint component **16**.

[0031] The channel **47** is configured to receive a further novel component of the prosthesis **10**, namely the stabilizing post **18**. The stabilizing post **18** projects upward from the intermediate component **16** to engage the intercondylar recess **32** in the femoral component **12**. As best illustrated in **FIGS. 1** and **2**, the stabilizing post **18** includes a base **55** that is sized for sliding engagement within the grooves **53** of the channel **47**. The base **55** and grooves **53** preferably form a close running fit so that the stabilizing post **18** can slide freely within the channel **47** without binding.

[0032] The stabilizing post **18** includes a spine **57** that projects from the base **55**. The spine **57** is sized for sliding movement along the exposed length of the channel **47** facing the femoral component recess **32**. The spine **57** has a height from the base **55** that is sufficient to span the height of the recess **32** and extend at least partially into the slot **33** when the femoral component and intermediate component are in articulating contact. The spine **57** serves to limit the AP movement of the femoral component **12**. In addition, a close running fit between the spine **57** and the recess **32** helps ensure that the femoral component **12** does not rotate relative to the intermediate component **16**, even when the tibial component rotates relative to the intermediate component.

[0033] As shown in **FIGS. 1-3** and **5**, the joint prosthesis also includes a locking member **20** that closes the posterior opening **49** of the channel **47**. Thus, the locking member **20** retains the stabilizing post **18** within the channel **47**. The locking member includes locking edges **69** on opposite sides of the member that are configured for locking engagement within the grooves **53** at the posterior end

of the channel **47**. The locking edges **69** and grooves **53** can be configured to achieve a variety of locking engagements therebetween to essentially permanently connect the two parts together and close the posterior opening of the channel. Thus, in one embodiment, the locking edges and grooves can form a press-fit engagement. In a specific embodiment, the press-fit engagement can be accomplished by complementary Morse taper angles. In another embodiment, the locking edges and grooves can be configured for a snap-fit engagement, sock as a locking tab and notch configuration. In yet another alternative, an independent fixation, such as a screw of even epoxy, can be used to lock the locking member **20** within the end of the channel.

[0034] The locking member **20** operates to trap the stabilizing post **18** within the channel. Thus, the member includes a stop surface **71** facing the posterior end **65** of the post **18**. The stabilizing post also includes an opposite anterior end **63** that contacts the closed end **51** of the channel **47**. The stabilizing post can thus move along the length of the channel from an anterior position **18'** to a posterior position **18"**, as depicted in **FIG. 5**.

[0035] The spine **57** of the stabilizing post **18** includes an anterior face **59** and an opposite posterior face **61**. Each face exhibits a pre-defined curvature for cammed movement of the stabilizing post during articulation of the femoral component **12** on the intermediate component **16**. In order to achieve this cammed movement, the femoral component, and more particularly the intercondylar recess **32**, defines a posterior-facing cam surface **77** at one end of the recess and an anterior-facing cam surface **79** at the opposite end of the recess, as shown best in **FIG. 6**. In essence, the two cam surfaces **77, 79** extend from the posterior and anterior ends of the slot **33** (**FIG. 1**). These cam surfaces bear against a corresponding face **59**, **61** of the spine **57** to urge the stabilizing post **18** along the channel in the AP direction. This feature allows the femoral component **12** to both roll and slide relative to the tibial component without exposing the articulating components and surfaces to the soft tissue surrounding the joint.

[0036] This rolling and sliding movement can be appreciated from a comparison of **FIGS. 7** and **8**. In **FIG. 7**, the stabilizing post **18** is in its anterior position **18'** and the femur and femoral component **12** is essential at its zero degree angle relative to the tibia and tibial component **14**. The posterior-facing cam surface **77** bears against the anterior face **59** of the spine **57**. As the femoral component **12** begins to roll in the direction of the arrow **R** (**FIG. 7**), the cam surface **77** bears against the anterior face **59** of the spine **57** to push the stabilizing post **18** posteriorly. Eventually, the post is pushed to its posterior position **18"**, as shown in **FIG. 8**. The slope and curvature of the anterior face **59** dictates the degree and speed of travel of the post along the channel **47**.

[0037] Once the stabilizing post is in its posterior position **18"**, the camming surface **77** no longer contacts the spine **57** as the femoral component continues to roll and translation anteriorly relative to the tibial component. Eventually, the femoral component is in the relative position shown in **FIG. 8** in which the femur is at an angle of about 120° relative to the tibia. The tab **34** engages the posterior indentation **73** in the locking member **20** to prevent further relative rolling and translation (in conjunction with tension in the collateral ligaments). In this position, the anterior-facing cam surface **79** contacts the posterior face **61** of the spine **57**.

[0038] As the femoral component undergoes relative rolling in the opposite direction, as designated by the arrow **R'** in **FIG. 8**, the cam surface **79** bears against the posterior face **61** to push the spine **57** anteriorly along the channel. When the cam surface **79** breaks contact with the spine, the stabilizing post is in its relative anterior position **18'** (**FIG. 7**). The spine thus prevents further anterior relative translation of the femoral component **12**. Again, it can be seen that none of the articulating surfaces or components impinge or are exposed to the surround soft tissue, even where the femoral component moves between the extreme relative positions shown in **FIGS. 7** and **8**.

[0039] The sliding stabilizing post **18** of the present invention provides a significant advantage during the total knee replacement procedure. In

specifically, the specific post can be selected during the procedure and tested to verify optimum knee movement for the particular patient. In other words, while the post **18** shown in the present figures exhibits a certain configuration, an array of posts can be available, all with different profiles. For instance, the posts can be configured to permit greater or lesser movement within the channel **47**. In addition, one or both of the faces **59**, **61** can be modified to achieve a specific camming action when contacted by the femoral component cam surfaces **77**, **79**.

[0040] Thus, in accordance with one feature of the present invention, the femoral and tibial components **12, 14** can be prepared bone surfaces. The intermediate or meniscal component **16** can be mounted to the tibial component **14** with the knee in flexion. A pre-selected stabilizing post **18** can be slid into the channel **47** and a temporary locking member can close the post within the channel. The knee can then be moved with the prosthesis in situ through certain degrees of motion to determine whether the selected post is optimum for the particular patient's anatomy. If not, the post can be removed and replaced with a different post having a different profile. Once an optimum stabilizing post has been found, the locking member **20** can be connected to the intermediate component **16** to lock the finally selected post **18** within the channel **47**.

[0041] The same process can be followed with respect to the locking member **20**. Locking members having different lengths along the channel can be provided to allow more or less sliding movement of the stabilizing post **18** within the channel **47**. In some cases, a locking member can be selected that does not permit any sliding of the post **18**.

[0042] While the invention has been illustrated and described in detail in the drawings and foregoing description, the same should be considered as illustrative and not restrictive in character. It is understood that only the preferred embodiments have been presented and that all changes, modifications and further applications that come within the spirit of the invention are desired to be protected. For instance, the intermediate component **16** may be made integral

with the tibial component **14**. In this case, the rotational degree of freedom would be eliminated.

[0043] In addition, the engagement of the stabilizing post **18** to the channel **47** can be modified so that the both ends of the channel are closed. For example, the channel can be provided with an enlarged top opening and the base **55** of the post **18** can be configured to fit through the enlarged opening and then pivot to engage the grooves **53** at the base of the channel. Engagement of the spine **57** within the intercondylar recess **32** will prevent pivoting of the post once it is disposed within the channel.

[0044] In the illustrated embodiment, the channel **47** is described as including one closed end **51** and an opposite open end **49**. Alternatively, both ends of the channel can be open with a corresponding locking member, such as the locking member **20**, closing each end to trap the stabilizing post **18** within the channel. The two locking members can be selected intra-operatively to optimize and orient the translation of the stabilizing post within the channel.